

№3 21651

MSFC-PROC-196  
April 12, 1962

GEORGE C. MARSHALL SPACE FLIGHT CENTER  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
HUNTSVILLE, ALABAMA

POTTING: CABLE ASSEMBLIES  
USING EPOXY RESINS,  
PROCEDURE FOR

I. PURPOSE: The purpose of this procedure is to establish a method for potting electrical connectors used in fabrication of cable assemblies by using epoxy resins as potting composition.

II. SCOPE: This procedure covers the methods, equipment, and materials to be used in potting electrical connectors of cable assemblies with epoxy resins.

III. REFERENCE

A. Supplementary documents. - The following documents, of the latest revision, may be used as supplementary data in conjunction with the provisions of this procedure:

SPECIFICATIONS

Federal

O-T 634	Trichloroethylene, Technical Grade.
IT-N-261	Methyl-Ethyl-Ketone, for Organic Coatings.

Military

MIL-W-5086	Wire, Electrical, 600 Volt, Copper, Aircraft.
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OTS PRICE

XEROX	\$ <u>4.60</u>
MICROFILM	\$ <u>1.58</u>

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SQT-3532

Army Ballistic Missile Agency

ABMA-PD-C-711

Cable and Harness Assemblies,  
Electrical, Missile System,  
General Specification for.

PROCEDURES

George C. Marshall Space Flight Center

MSFC-PROC-158

Soldering of Electrical Connections (High Reliability), Procedure for.

B. Availability. - Copies of specifications, standards, procedures, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

C. Other publications. - The following documents form a part of this procedure to the extent specified herein. Unless otherwise specified, the issue in effect on date of invitation for bids shall apply:

Minnesota Mining and Manufacturing Company

Processing Bulletin 294-7018-61 (38.2) M for XR-5001 Primer, Solvent Based, Scotchcast.

Processing Bulletin 274-1638-38 (90.1) M for XR-5038 Resin, Epoxy, Scotchcast.

(Application for copies should be addressed to Minnesota Mining and Manufacturing Company, 900 Bush Avenue, St. Paul 6, Minnesota.)

IV. DEFINITIONS AND ABBREVIATIONS

Not applicable.

V. RESPONSIBILITY

A. Design activity. - Each design activity of George C. Marshall Space Flight Center (MSFC) shall be responsible, for implementing the provisions of this procedure. This procedure shall be applicable to all phases of potting cable assemblies when epoxy resins are used.



B. Quality Assurance Division. - The Quality Assurance Division of MSFC shall be responsible for monitoring the requirements of this procedure during fabrication, assembly, modification, and repair operations.

## VI. PROCEDURE

A. Materials. - The following materials, substitutions, deviations, etc., approved by the cognizant MSFC electrical design activity, shall be used:

1. XR-5038 Scotchcast Resin      Minnesota Mining and Manufacturing Company.
2. XR-5001 Scotchcast Resin Primer      Minnesota Mining and Manufacturing Company.
3. Trichloroethylene (Type I) Solvent Cleaner
4. Methyl-Ethyl-Ketone Solvent Cleaner

### B. Equipment.

1. Weighing equipment. - Weighing equipment for accurately measuring the potting compound constituents shall be provided. When weights are expressed in grams, a gram balance sensitive to 1.0 gram shall be used for weighing quantities of 250 grams or less. A pound balance sensitive to 0.1 pounds shall be used for weighing quantities up to 30 pounds when weights are specified in pounds.

2. Holding rack. - A rack composed of a laboratory "Flexaframe" or similar parts fitted with holding clamps shall be available. It shall be constructed for easy rearrangement so the cable components can be held rigid and in proper alignment to facilitate proper injection of the potting compound.

3. Injection gun. - An air operated caulking gun equipped with disposable polyethylene nozzle and liner shall be used for injecting the potting compound into the connectors. The gun capacity and nozzle size shall depend on the quantity and type of connectors being potted. Disposable nozzles and liners are required for use with the potting compounds specified in this procedure.

4. Brushes. - Small disposable brushes shall be used for applying the potting compound.

5. Vacuum chamber. - An evacuation system consisting of a pump and a vacuum chamber capable of producing a differential pressure of at least 29.5 inches of mercury shall be used to minimize entrapment of air bubbles during potting operations.

6. Mixing containers. - Containers of a non-porous material such as polyethylene, glass, or metal shall be used to mix the compound and activator.

7. Pressure source. - An air pressure source capable of delivering a minimum of 10 pounds per square inch gage pressure of moisture free air shall be available.

8. Paper, abrasive. - An abrasive paper (40 to 60 grit) manufactured by the Minnesota Mining and Manufacturing Company or approved equal, shall be used to roughen the surfaces of neoprene cables as required for pre-potting operations.

C. Storage life of compounds and primers. - Storage life limitations of potting compounds and primers, in unopened containers at temperatures less than 80 degrees Fahrenheit (F), are shown in table II. Compounds and primers which have been stored for periods greater than those shown in table II shall be approved by the quality control agency before usage. Do not retain or store compounds and primers that have previously been opened.

Table II. Storage life of compounds and primers

Compound or primer	Storage life
XR-5038	12 months
XR-5001	12 months

D. Safety precautions.

1. Work with epoxy materials shall be carried out only in a well-ventilated area because of toxicity of fumes. Body contact with the resin and activator must be avoided; therefore, the use of protective clothing is highly recommended. Should skin contact with epoxy occur, wash the exposed area immediately with mild soap and water. In case of eye contact, flush eyes immediately with copious quantities of clean water and then secure medical attention. Prolonged and repeated breathing of the vapors shall be avoided.

2. Cleanliness in the potting area must be faithfully practiced. Bench tops shall be protected from spillage with disposable paper coverings and floors shall be cleaned frequently. Clothing, when soiled by potting materials, shall be changed regularly and laundered prior to reuse.

3. The Scotchcast XR-5001 Primer shall be treated the same as a highly volatile, flammable solvent and proper precautions shall be taken in addition to those listed in paragraph VI.D.1 above.

4. Observe normal safety precautions when using solvent or cleaning fluids. Never use methyl-ethyl-ketone, toluene, xylene or related solvents to remove materials having an epoxy base from the skin.

5. All containers shall be labeled as to contents, both before and after mixing and shall show the pot life expiration time.

E. Inspection prior to potting. - Prior to potting, the connector, with assembled cable, shall have passed an inspection for workmanship and an electrical check for continuity and short-circuits.

F. Preparation of cable assemblies. - To insure proper adhesion of the potting compound to all components of the connector, the inner body of the connector, wires, boot, and all other materials that will contact the potting compound must be free of any trace of grease, oil, wax, or other contaminants. Any surface which has not previously been thoroughly cleaned shall be cleaned by using a small stiff bristled brush and methyl-ethyl-ketone, trichloroethylene, or other approved solvent. The potting operations shall be accomplished as follows:

#### CAUTION

For the protection of personnel, safety precautions must be observed in the use of solvents; according to chemical composition. When using solvents, as specified herein, allow no smoking or open flame within 25 feet from solvent and make sure the area is properly ventilated at all times. Allow all materials cleaned with solvents to air dry completely prior to potting.

1. To insure proper adhesion of the potting compound to neoprene sheath cables, the surface of the sheath shall be roughened with abrasive paper (see 10-10-10).

2. The connector shall be assembled with a mating connector to insure proper contact alignment during potting. The mating connector shall remain in place until sufficient curing time has elapsed to preclude any movement which could cause misalignment.

3. The connector shall be clamped in an upright, level and secure position to prevent any movement of the components which could cause spilling of the potting compound from the potting mold. The wire or cable shall be clamped in a vertical position to relieve any lateral strain on the soldered joints. The wire bundle shall be centered, with respect to the connector, with no conductor touching the potting boot.

4. Connectors that have solder pots which extend above the normal mold level (example AWG sizes 8 and larger), shall have the top level of the mold extended sufficiently high for the potting to extend at least 1/4-inch over the wire insulation for unshielded cable.

5. Cables that have a "floating" shield (where the shielding braid is terminated by trimming the braid back from the end of the cable insulation and is left ungrounded without the use of a ferrule,) (see figures 4 thru 13) shall be secured in place with lacing cord having a maximum of 5 wraps. The shield terminating (braid) shall be embedded in the potting compound for a minimum of 3/16-inch in depth and the shield end shall extend a minimum of 3/16-inch from the end of the wire (conductor) insulation. In the case of small connectors, the potting mold shall be extended to comply with minimum spacing requirements.

6. For shielded braid cable having 9 or more shields, a Hyring, (two-piece crimped ferrule, see figures 14 thru 33), or approved equal, shall be used. For 8 or less shielded conductors, a butt end configuration shall be used..

7. In all cases of shielding, bonding, and grounding, the applicable specifications and design requirements for the electrical configuration shall govern. All potting applications shall be coordinated with, and shall conform to the basic electrical requirements for both shielded and unshielded cable.

8. Bendix "Pygmy" connectors, or approved equal, of a potting type which have a locking ring (PT06) shall be inspected for "ring-binding" immediately prior to potting. This is accomplished by pressing the potting boot onto the adapter ring, turning the adapter ring down tight against the locking ring, and then backing the adapter ring off 1/4- to 1/2-turn. The locking ring should then rotate freely, as required for proper connector engagement. Do not disturb the adjustment of connectors which previously have been checked for ring binding and have been sealed.

2. Misalignment of contacts shall be prevented during the potting process. Precautions to be observed prior to potting are as follows:

- a. Before and during the potting, movement of the cable wire shall be held to a minimum and no movement shall be allowed during the potting process.
- b. The proper stitching interval of the lacing or tying wire when used or installed on the cable, measured from the potting mold, are listed in table I.

Table I. Cable stitching interval

Cable assembly diameter	Interval (approximate)
1/4 inch	3/4 inch
1/2 inch	1-1/2 inches
1 inch	2 inches
over 1 inch	3 inches

When the cable diameter is between the listed sizes, revert to the smaller diameter for applicable stitching interval (example: Harness size 3/8-inch, use 3/4-inch stitching interval). In all cases, there shall be enough tension on the cable to keep it perfectly straight from the pins to the beginning of the lacing or tying.

G. Inspection (in-process). - Inspection shall be performed to insure high quality workmanship to prevent shorts, opens, air bubbles, voids, foreign particles, and to prevent misalignment of contacts. Quality workmanship is a result of the skill of the worker, and any flaws incurred during soldering, cleaning, compound mixing, compound weighing, and potting of the connector shall be determined and eliminated by frequent in-process inspections. Completed harness or cable assemblies shall be subjected to 100 percent inspection.

H. Application of Scotchcast primer XR-5001. - Apply primer to the adapter ring and the potting boot surface adjoining the adapter ring using a small brush. Prior to drying of the primer, screw the adapter ring on the connector grommet finger-tight and back off the ring from 1/4 to 1/2 of a turn. Air dry primed area until the surface is not "tacky". This application will seal the adapter ring to the grommet and the potting boot to the adapter ring which will in turn prevent leakage of the potting compound during application.

**I. Mixing and application of potting compounds.**

1. The activator and base resin shall be mixed according to the instructions by the manufacturer. Special care shall be observed to avoid the inducing of air bubbles into the potting compound during mixing. Care shall be taken to prevent voids and to eliminate air bubbles regardless of the method used to inject or pour the compound into the mold or potting boot. Air bubbles shall be reduced to a minimum, as soon as possible after the base resin and activator have been mixed, by vacuum evacuation or other approved method. Vacuum evacuation shall be used if suitable facilities are available. The vacuum evacuation, if used, shall be of the necessary magnitude and of sufficient duration to remove air bubbles that would appear as voids in the potted configuration. The evacuation time shall be consistent with the pot life of the mixture in order to retain sufficient working time for the potting procedure. Each part of XR-5038 (base resin and activator) shall be thoroughly mixed before combining to produce the potting compound. Proportions by weight shall be: 5 parts base resin-"A", 1 part activator-"B" mixed as follows:

- a. Combine the two parts in the above proportions and mix thoroughly with a slow moving mechanical mixer or with a paddle by hand until the color of the mixture is uniform. Do not whip the mixture by rapid agitation as this introduces air which is difficult to eliminate.
- b. Transfer the mixed compound from the mixing container to the pressure gun liner by carefully and slowly pouring the compound down the side of the liner until the desired level in the liner is reached. Put the pressure cap in place and insert the liner into the gun. Attach the correct size nozzle for the applicable potting job and adjust the air pressure supply to approximately 10 pounds per square inch gage.
- c. Slowly inject the potting compound into the prepared connector. Flow the compound carefully down one side of the connector and fill the void space around the wires and pins. Observe precautions to avoid air entrapment during flow operation. Continue injection of the compound until a predetermined level is attained. Allow the compound to set for a few minutes to allow entrapped air to escape.

Replenish compound to the required level. The nozzle tip shall be a size which will permit easy access between the electrical contacts but large enough to facilitate filling the applicable connector. (Disposable gun liners, nozzles and end caps are essential to facilitate cleaning.)

- d. The pot life of XR-5038 compound is 35 minutes at 75 degrees F. The compound can be poured and gel cured at room temperature. For heat curing, both the mold and the compound should be at cure temperature during pouring to aid in impregnation and to aid in the elimination of air.
- e. The potted connector shall be allowed to stand undisturbed until the cure is complete. The compound cures in approximately 24 hours at room temperature (75 degrees F). For an accelerated cure, first allow the connector to remain undisturbed for 1 hour to permit the escape of entrapped air bubbles. The connector shall then be heated to 150 degrees F by the use of an oven or heat lamps. This temperature shall be maintained for approximately 6 hours to complete the cure. Cure time will vary according to mass (quantity) of compound. Connectors for large power-type cables (see figure 34) may require a longer cure time due to pressure exerted on the compound by the stiff wire. Curing schedules shall conform to the above requirements. Any departure from prescribed techniques of curing shall be based on the application and mass of resin used together with authorized approval.

J. Inspection (final). - The potted cable shall be inspected for general appearance and quality of workmanship. The surfaces of the potted area shall be free from surface voids, blisters, tackiness (after curing has been accomplished) and other similar defects. The cable shall be flexed a maximum of five times at the joint of the cable and the potted connector to determine that the material is securely bonded. Defectives that will (as determined by the inspector) adversely affect the serviceability relative to the intended use of the cable assembly shall be cause for rejection of the applicable potted assembly.

VII. REPORTS: Not applicable

VIII. MODIFICATIONS: All modifications regarding materials or changes to this procedure shall be submitted to Chief, M-ASTR-EE, for approval. No deviations from this procedure are permissible unless properly approved by the Chief, M-ASTR-EE.

Custodian:

National Aeronautics and  
Space Administration

Preparing activity:

George C. Marshall Space  
Flight Center

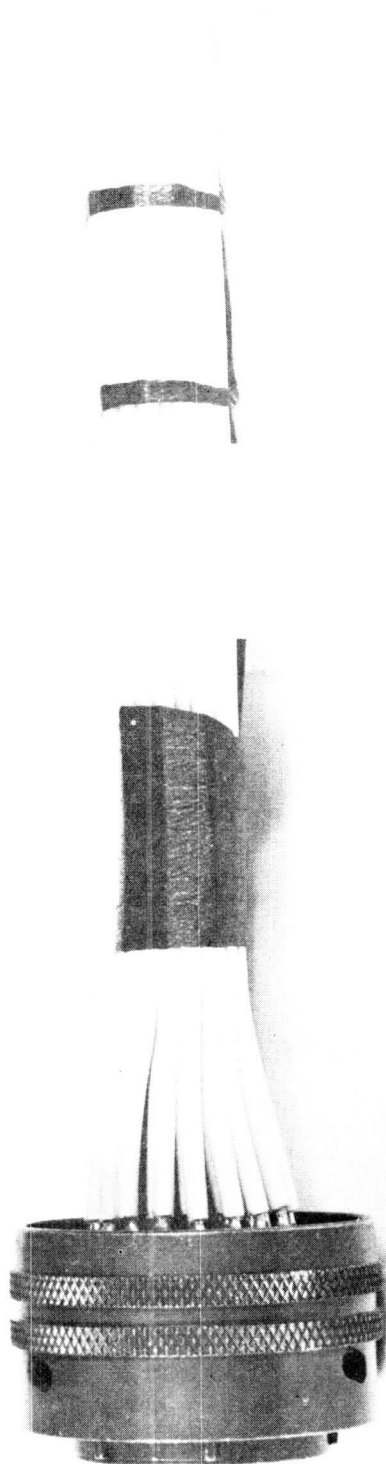


APPENDIX I  
POTTING CABLE ASSEMBLIES USING  
EPOXY RESINS, PROCEDURE FOR

ILLUSTRATIONS

1. This appendix contains pictorial examples of typical potting methods used at George C. Marshall Space Flight Center as follows:
  - a. Miniature type connectors potted with nylon jacketed wire are shown in figures 1, 2 and 3.
  - b. Miniature type connectors potted with floating shields are shown in figures 4, 5 and 6.
  - c. Miniature type connectors potted with floating shields with the insulation rolled back are shown in figures 7, 8 and 9.
  - d. Miniature type connectors potted with shields in a butt end configuration, shields grounded through pin are shown in figures 10, 11, 12 and 13.
  - e. Miniature type connectors potted with shielded wires terminating in a Hyring. The shields are grounded through a pin of the connector as shown in figures 14, 15, 16 and 17.
  - f. Miniature type connectors potted with a neoprene jacketed cable that have their shields terminated in a Hyring. The shields are grounded through a pin of the connector as shown in figures 18, 19 and 20.
  - g. Miniature connectors potted with shielded wires terminating in a Hyring. The shields are grounded through a pin of the connector as shown in figures 21, 22 and 23.
  - h. MS connectors potted with a few shielded wires that are grounded to one side of the connector are shown in figures 24, 25 and 26.
  - i. MS connectors potted with a few shielded wires that are grounded to each side of the connector are shown in figures 27, 28 and 29.

- j. MS connectors potted with the shielded wires terminating in a Hyring. The shields are grounded through a pin of the connector as shown in figures 30, 31, 32 and 33.
- k. Heavy Duty Power Cable Connector used in ground equipment. The potting is done through a hole in the connector as shown in figure 34.



**BENDIX PYGMY TYPE CONNECTOR WITH NYLON JACKETED  
NO . 20 WIRE .**

Figure 1

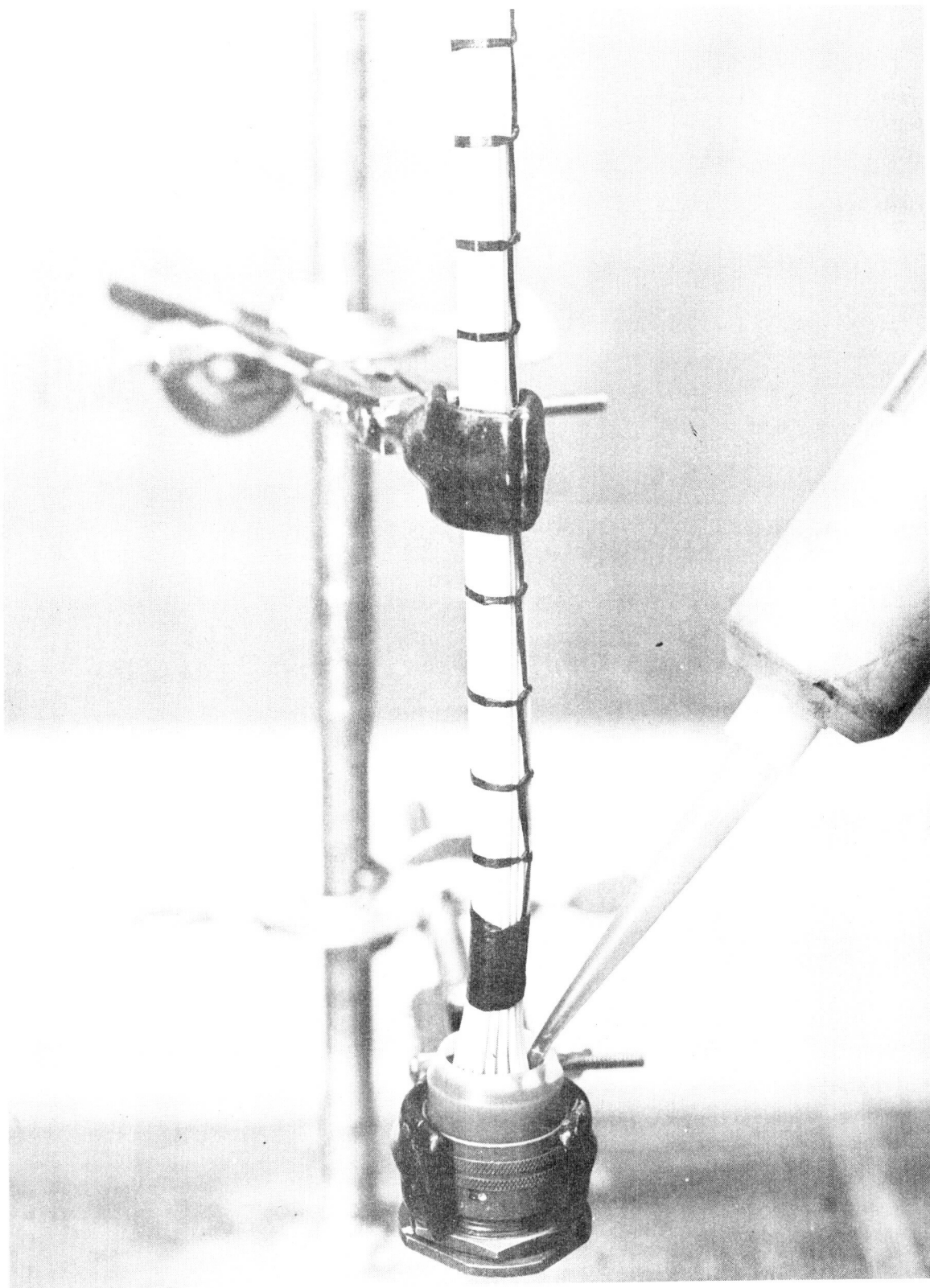


Figure 2

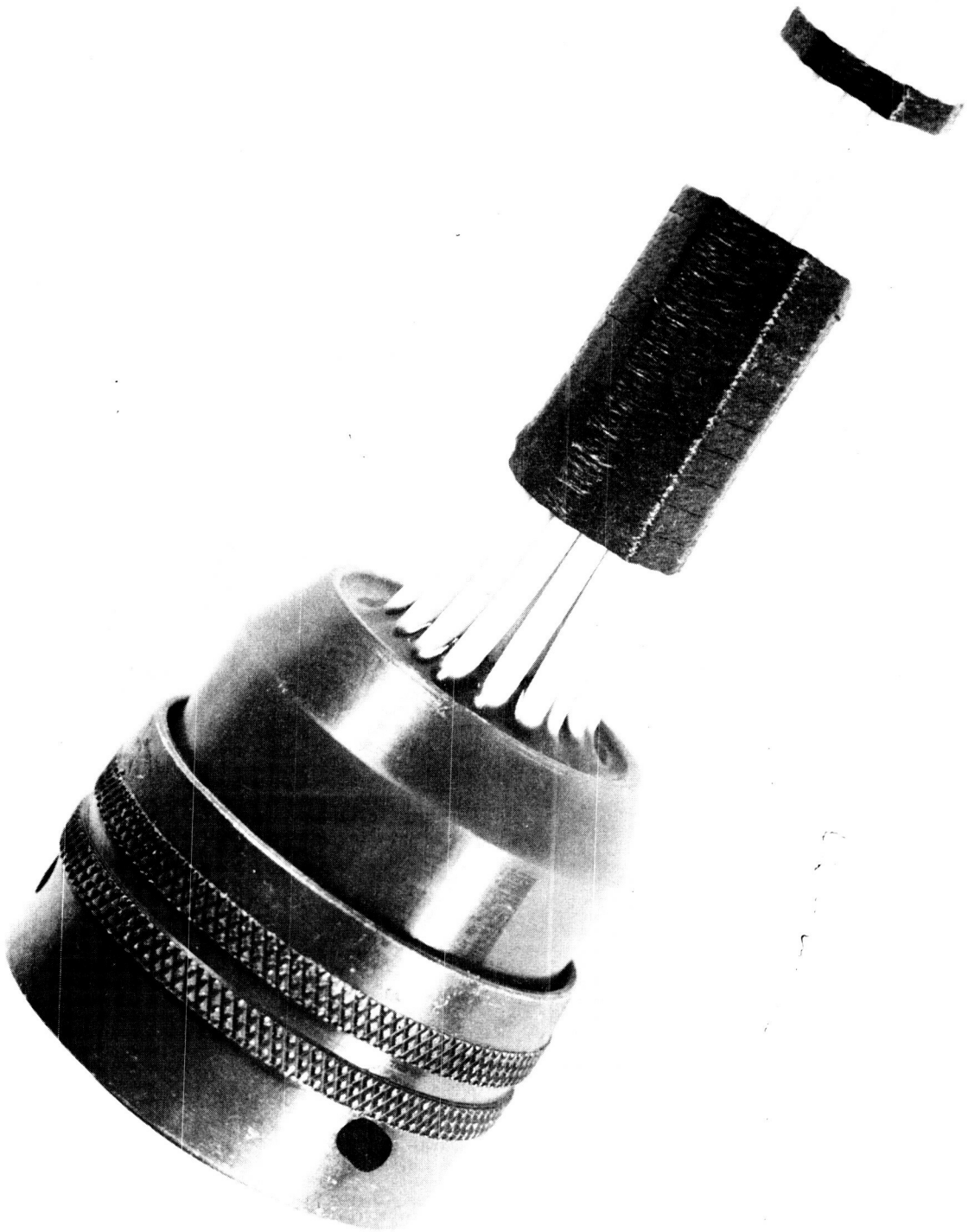
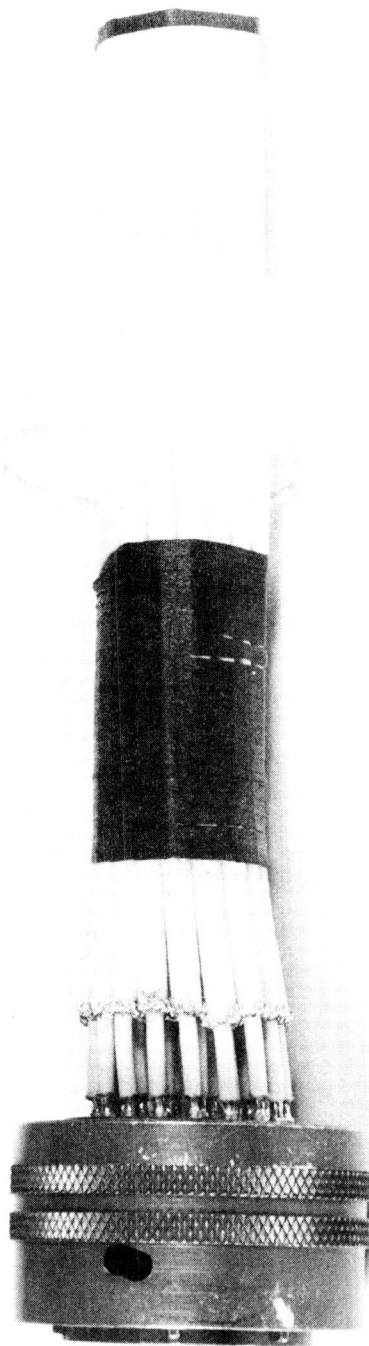


Figure 3



**BENDIX PYGMY TYPE CONNECTOR WITH FLOATING SHIELD.  
SHIELDS NOT INDIVIDUALLY INSULATED .**

Figure 4

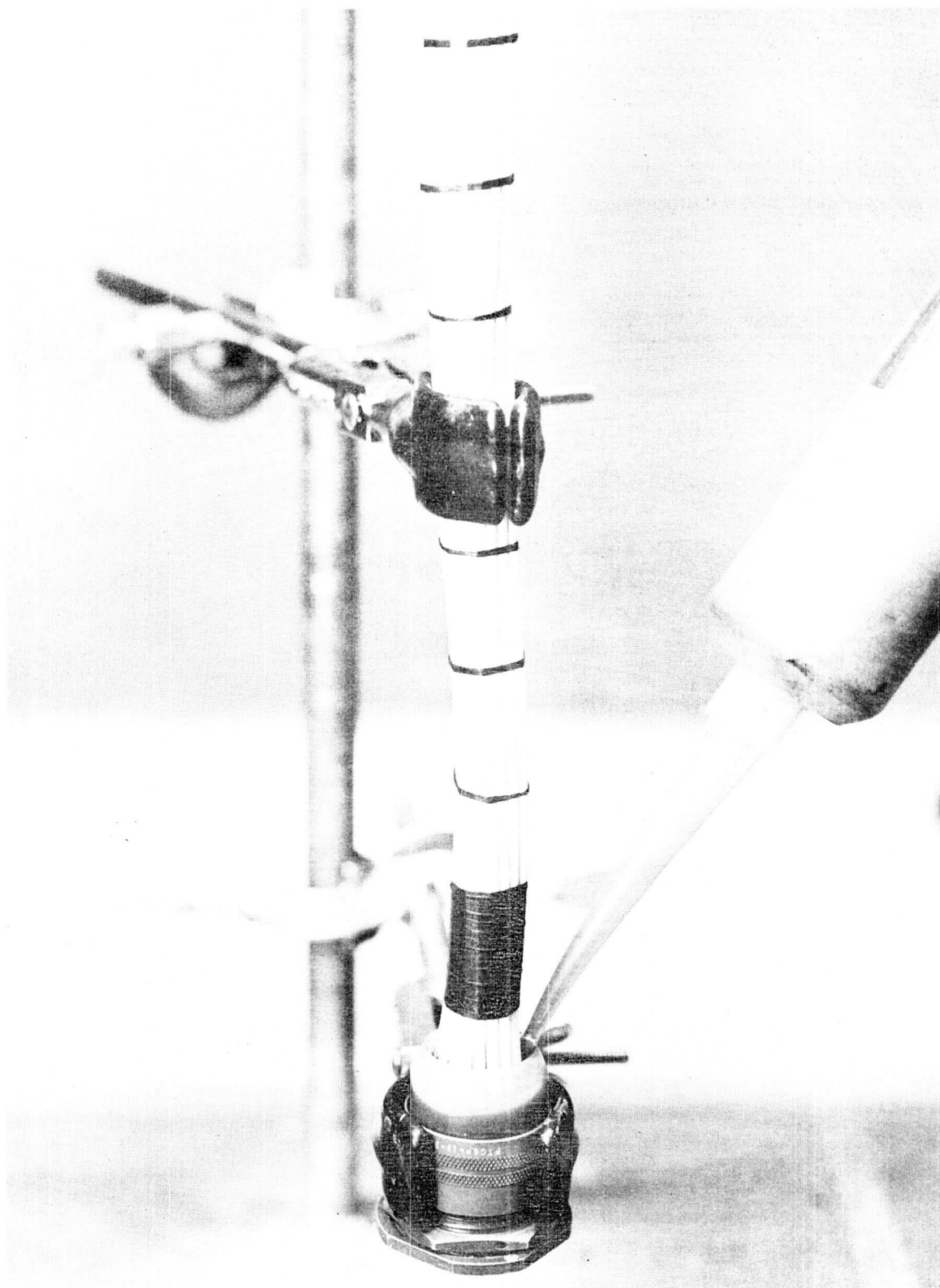


Figure 5



Figure 6



BENDIX PYGMY TYPE  
CONNECTOR WITH  
FLOATING SHIELD .  
OUTER JACKET ROLLED -  
BACK TO INSULATE  
TERMINATED SHIELD .

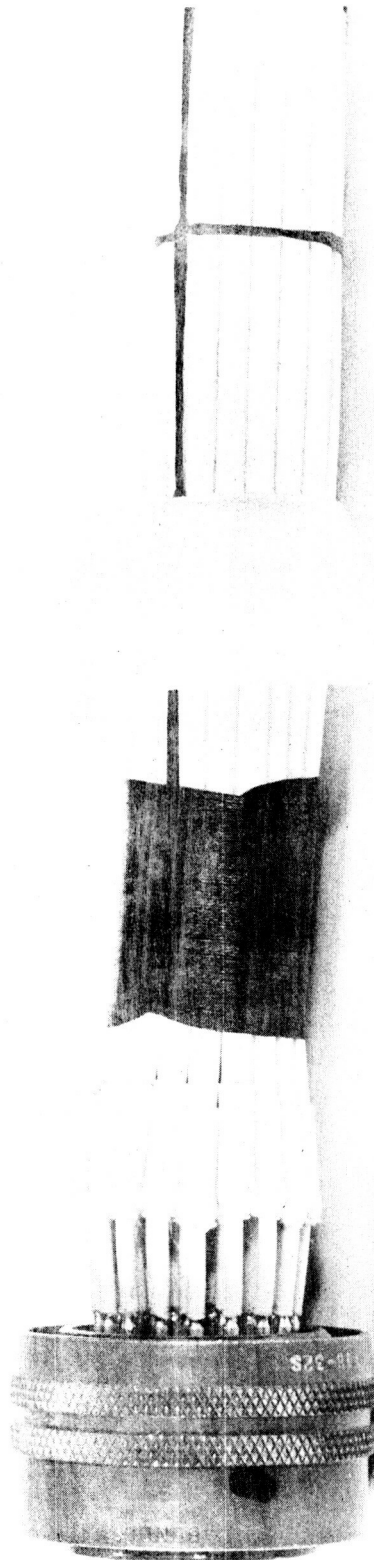


Figure 7

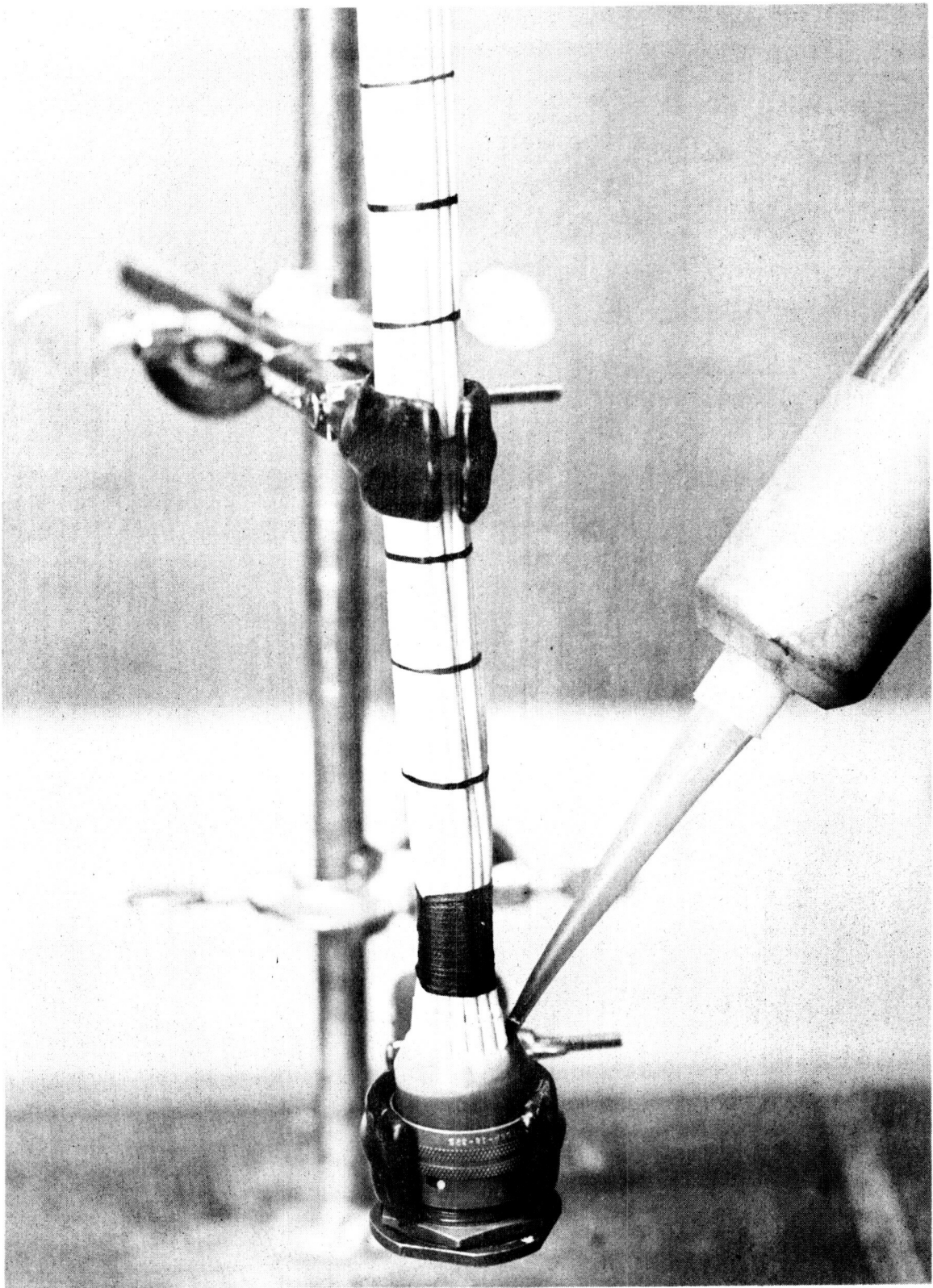


Figure 8

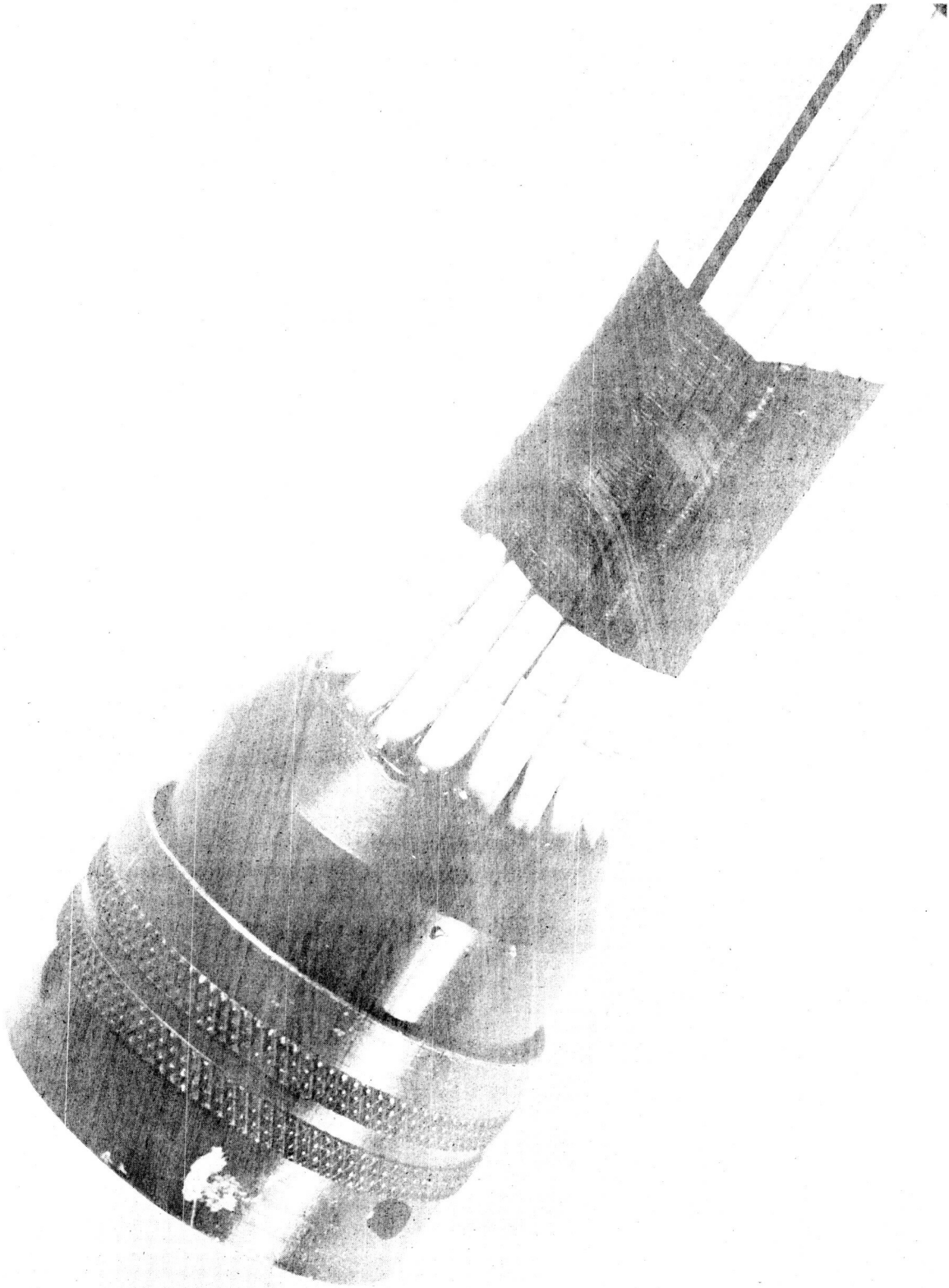


Figure 9



**FIGURE 10**

**BENDIX PYGMY TYPE CONNECTOR WITH A SMALL NUMBER OF SHIELDED WIRES. THESE SHIELDED WIRES ARE TERMINATED IN A BUTT END CONFIGURATION AND GROUNDED THROUGH A PIN.**

Figure 10

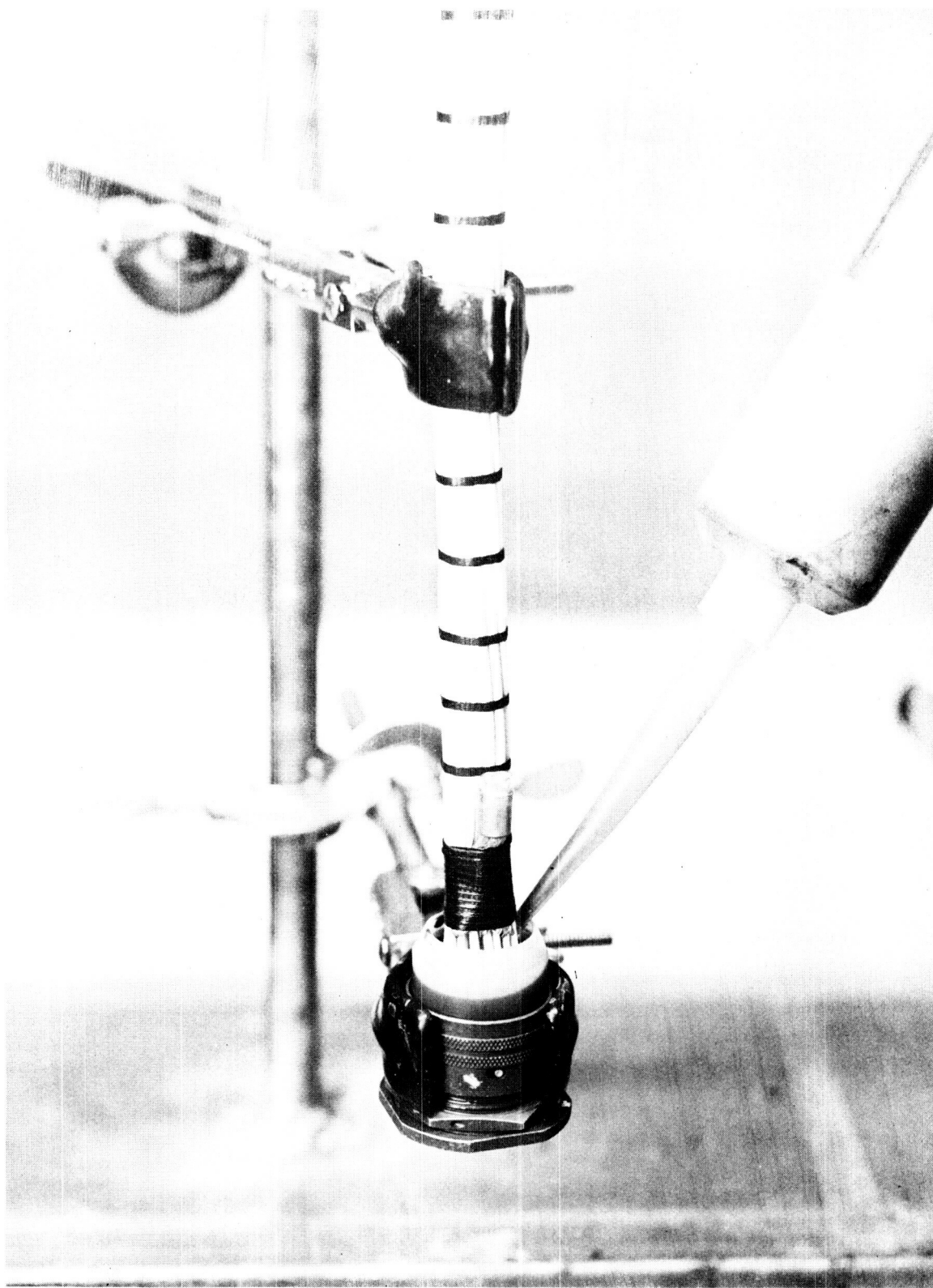


Figure 11

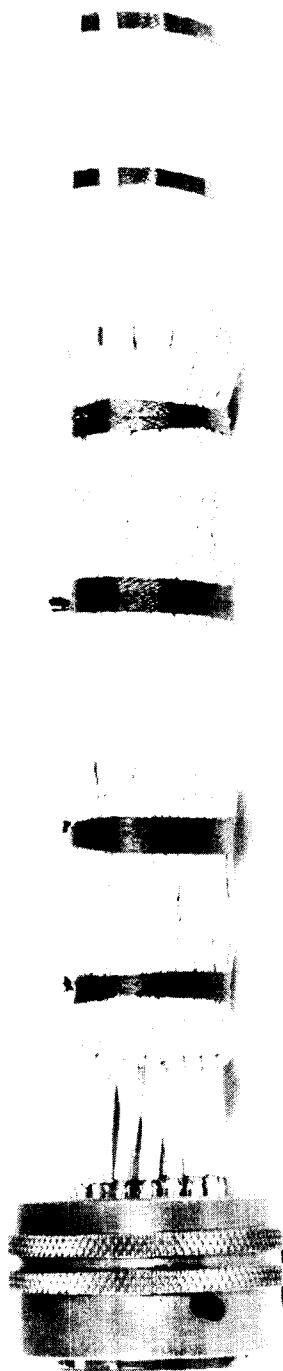


Figure 12



**SHIELDING INSULATED BY SLEEVE .**

Figure 13



**BENDIX PYGMY TYPE CONNECTOR WITH MANY SHIELDED WIRES  
TERMINATING IN A HYRING. THE SHIELDS ARE GROUNDED  
THROUGH A PIN OF THE CONNECTOR.**

Figure 14



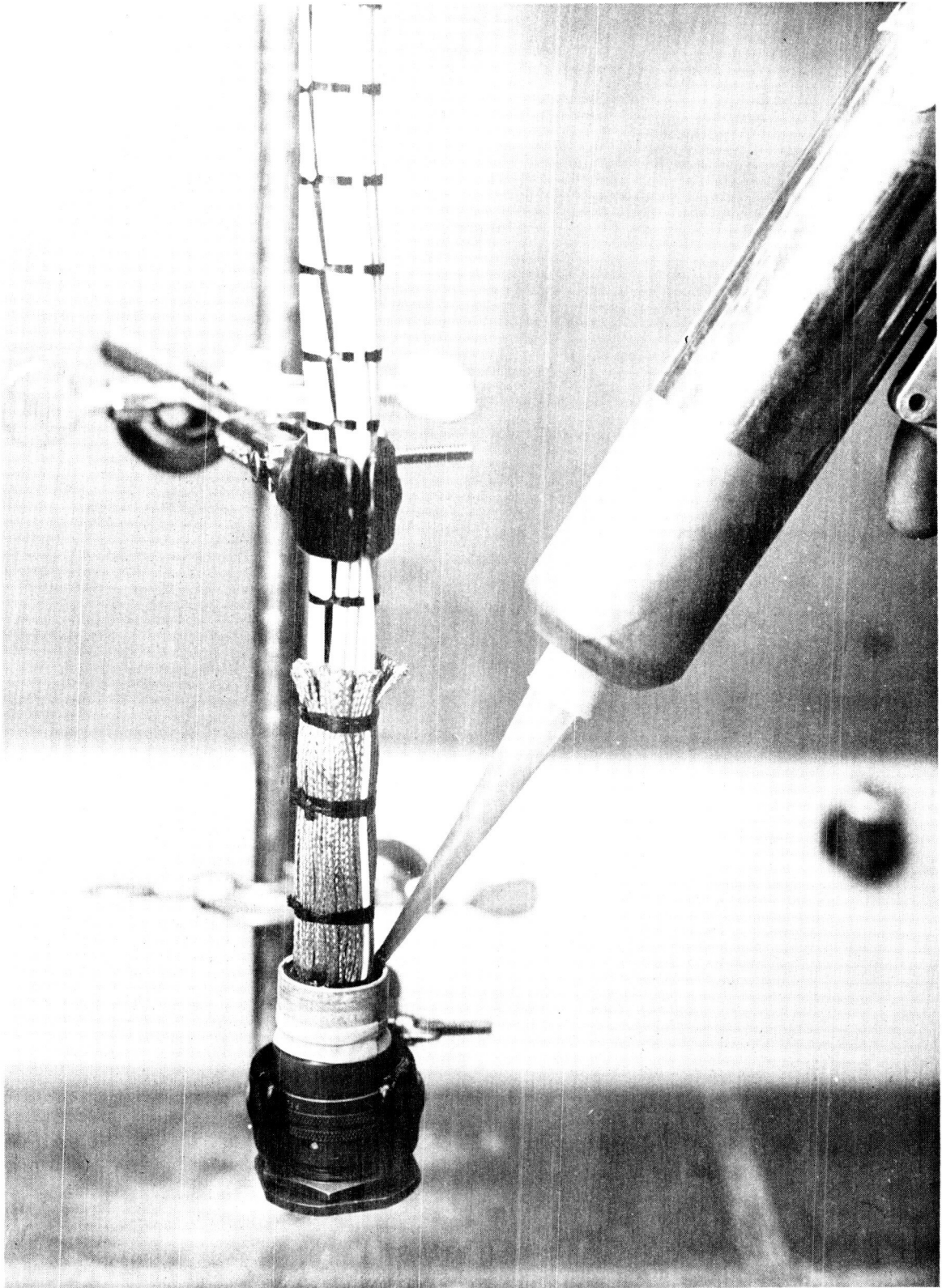
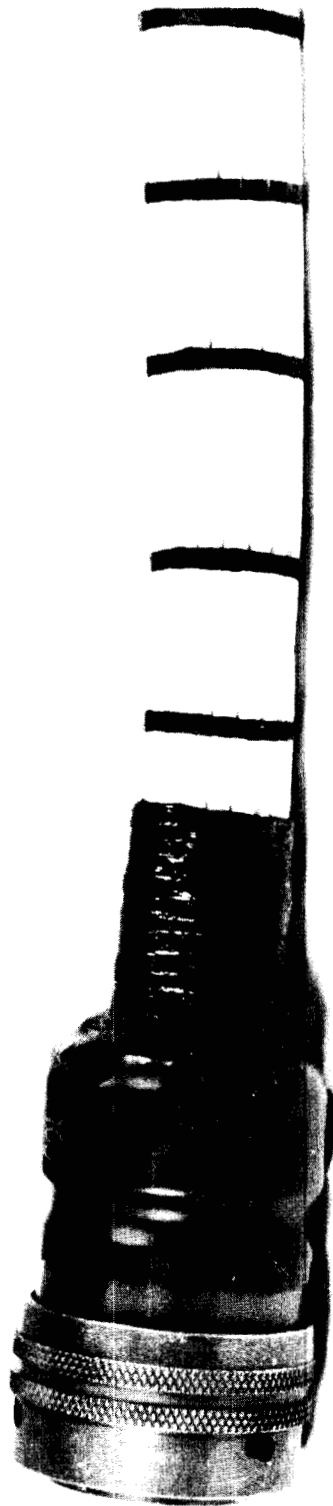


Figure 15

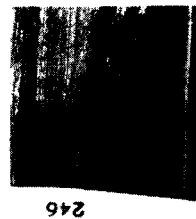


Figure 16



## SHIELDING INSULATED BY SLEEVE

Figure 17



CONNECTOR WITH A  
NEOPRENE JACKETED  
CABLE ATTACHED.  
THE SHIELDS ARE  
TERMINATED IN A  
HYRING THAT IS  
GROUNDED THROUGH  
A PIN OF THE  
CONNECTOR.

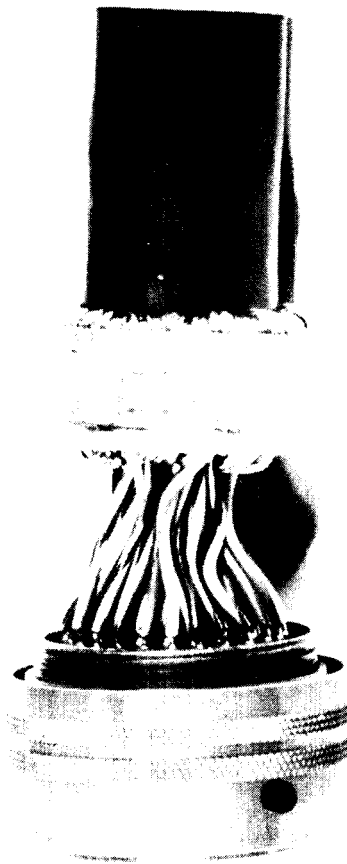


Figure 18

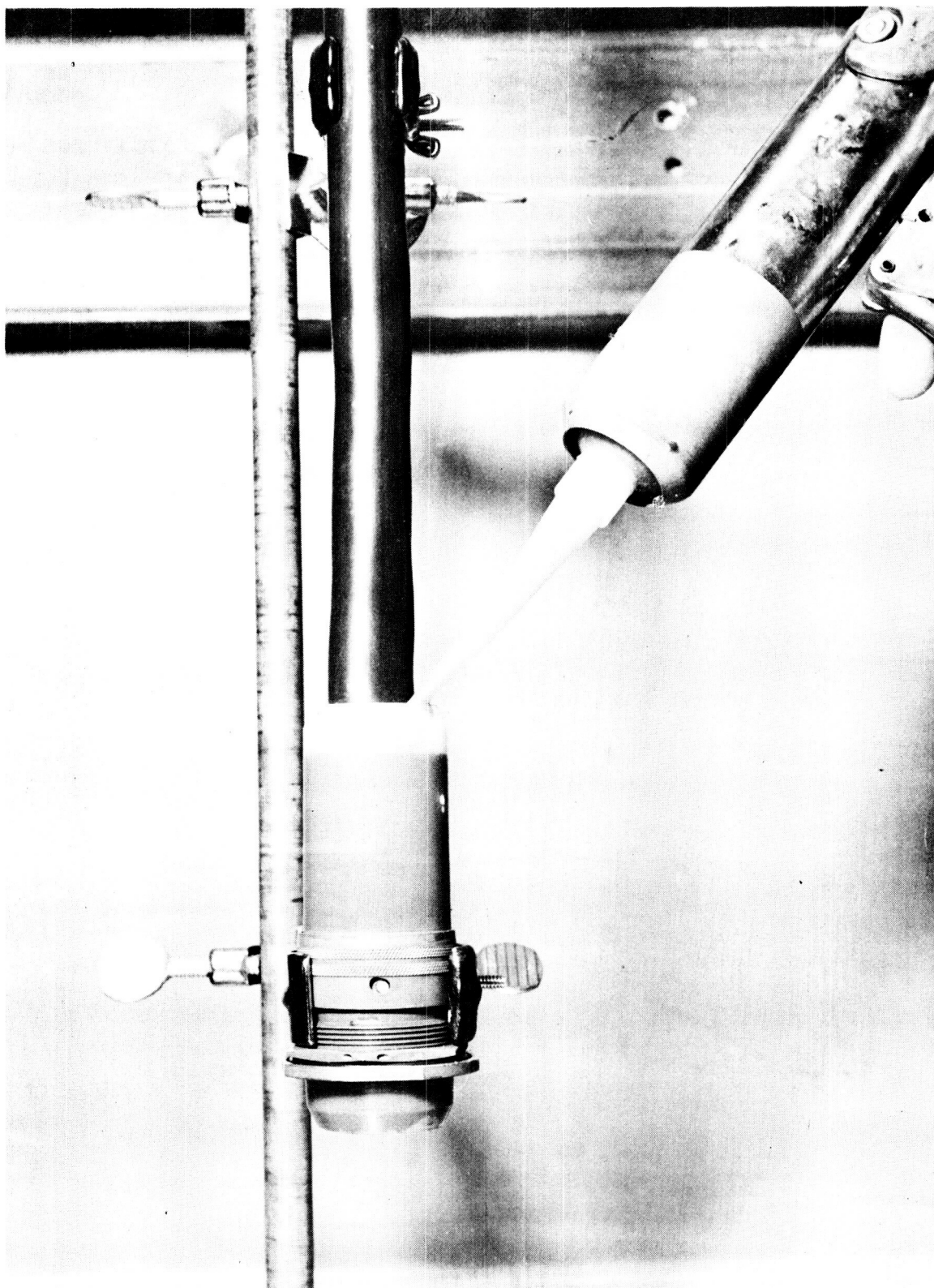


Figure 19

**NEOPRENE JACKET IS  
EMBEDDED IN THE  
POTTING COMPOUND  
A MINIMUM OF  
.25 INCHES .**

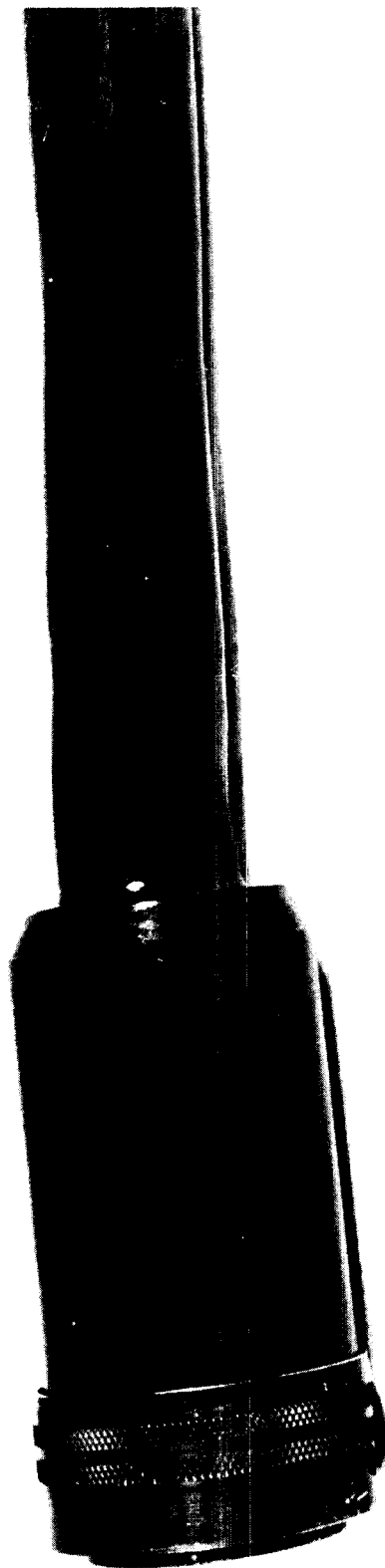
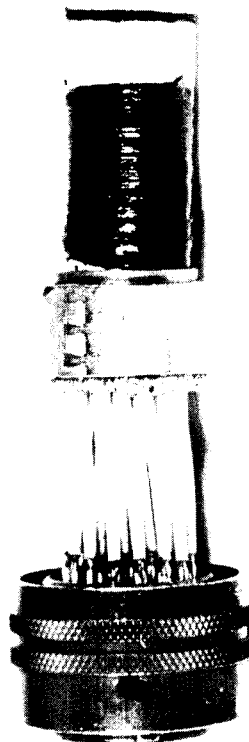


Figure 20



BENDIX PYGMY TYPE  
CONNECTOR WITH MANY  
SHIELDED WIRES  
TERMINATING IN  
A HYRING .



THE SHIELDS ARE GROUNDED THROUGH A PIN IN THE  
CONNECTOR. THE HYRING IS POTTED .

Figure 21

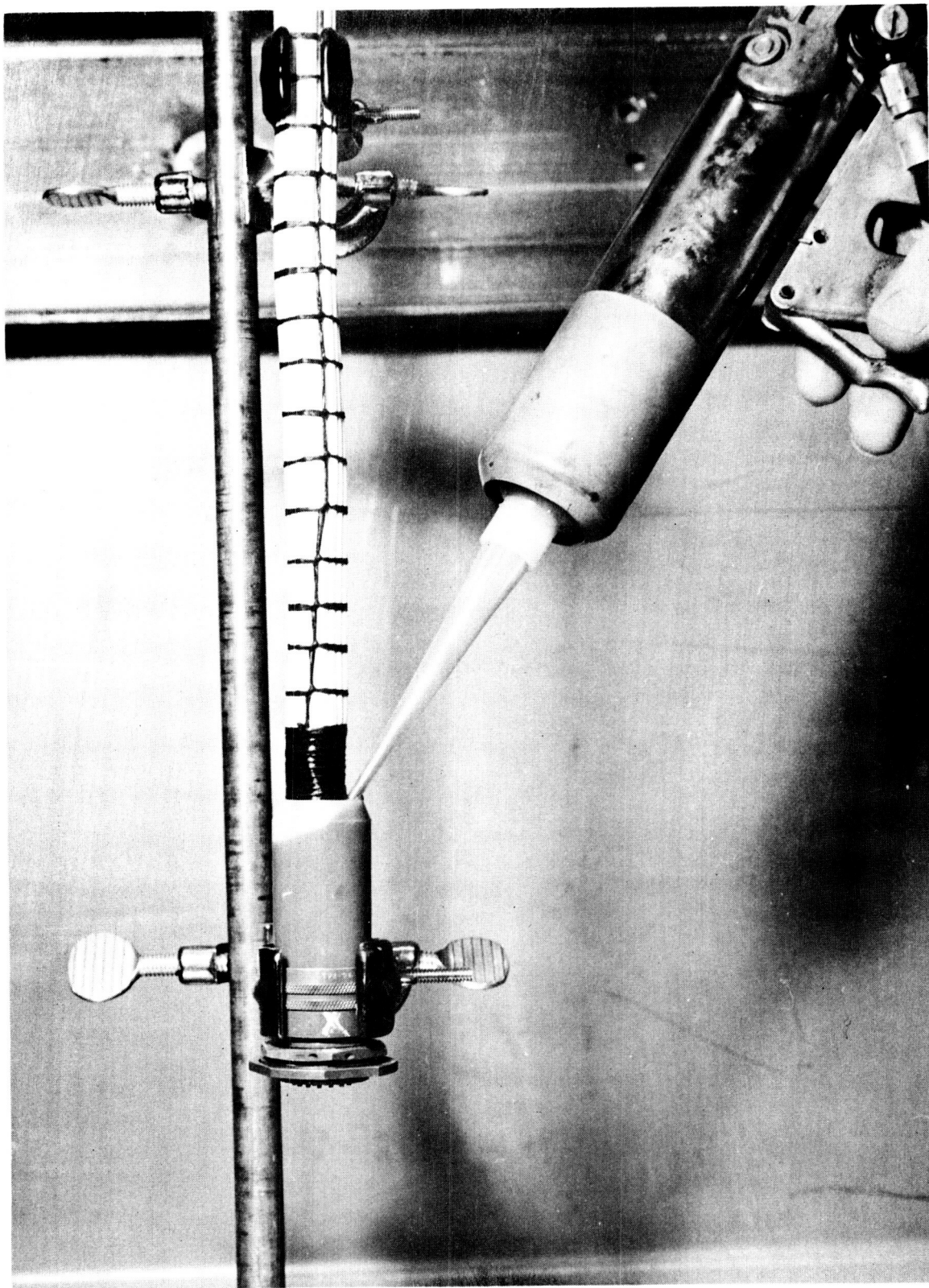


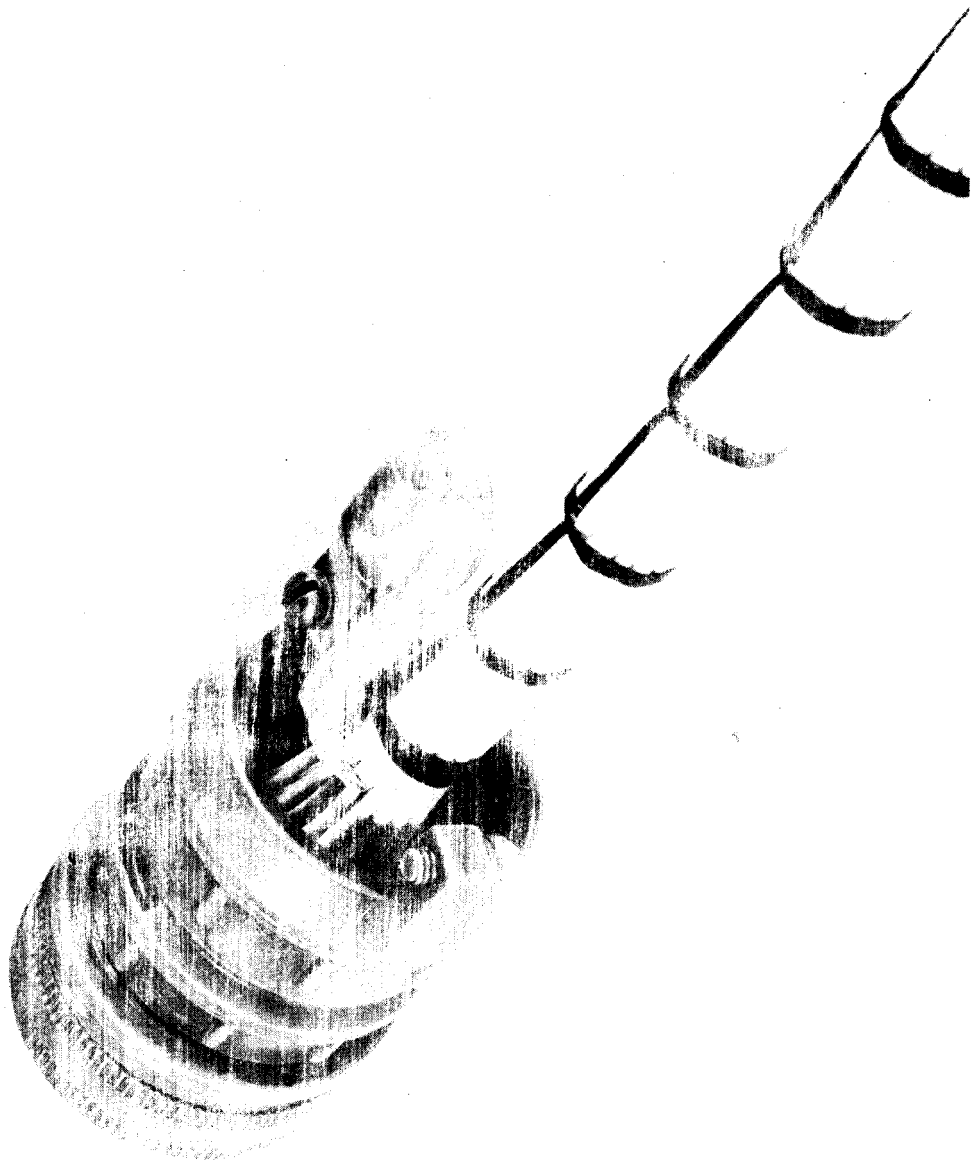
Figure 22





Figure 23

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MS CONNECTOR WITH SHIELDS GROUNDED ON ONE SIDE  
OF CONNECTOR .

Figure 24

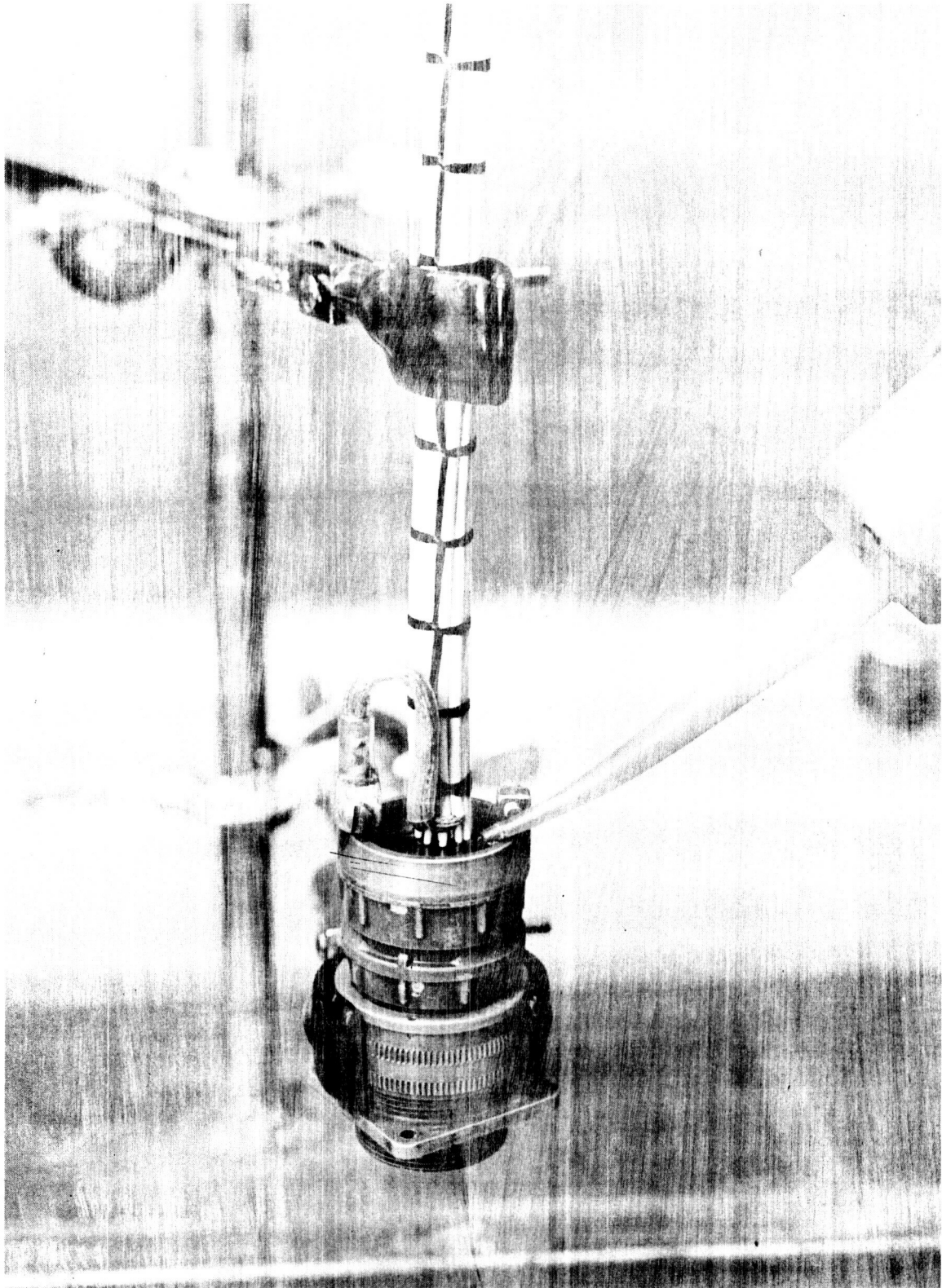


Figure 25

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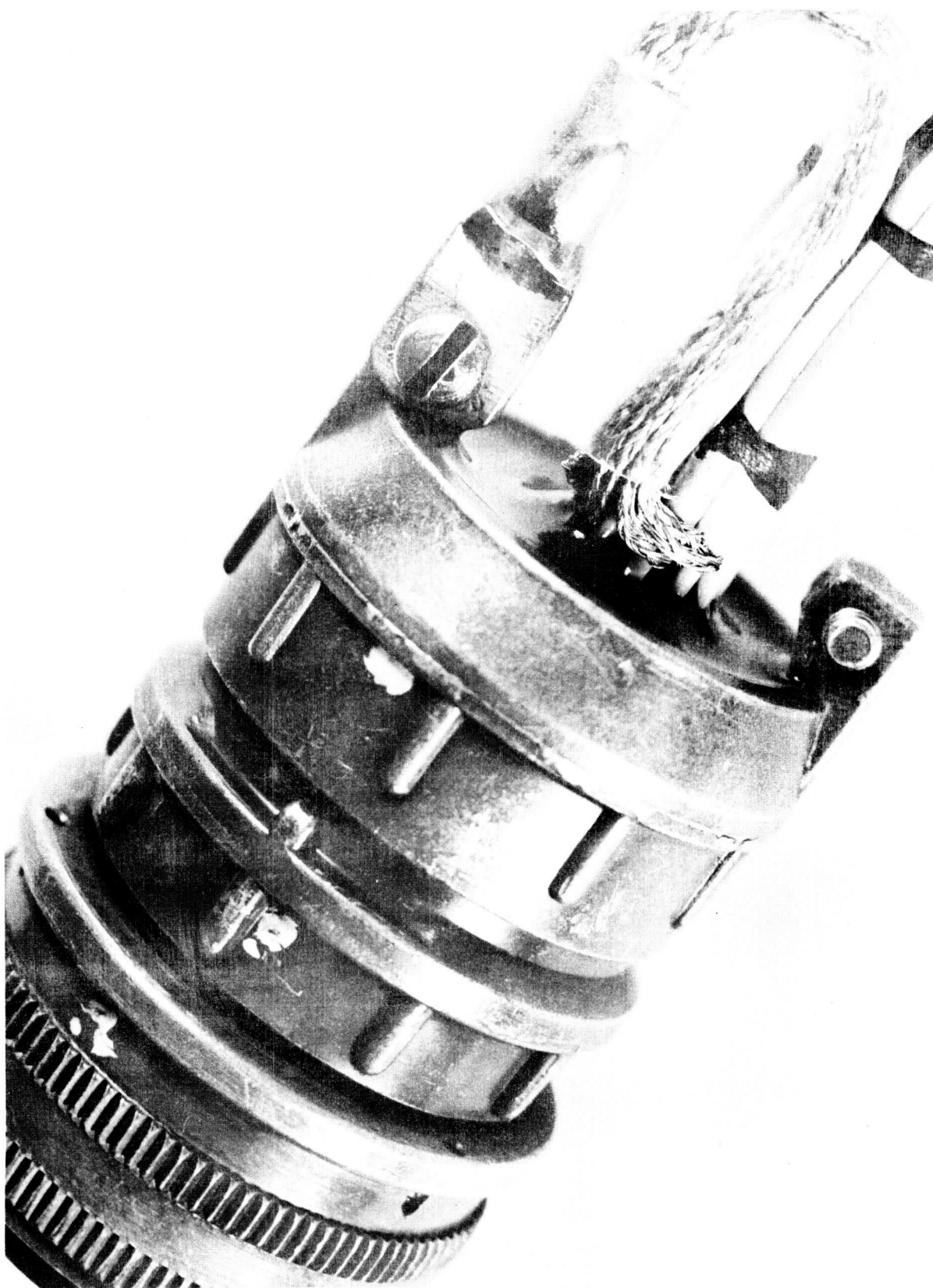
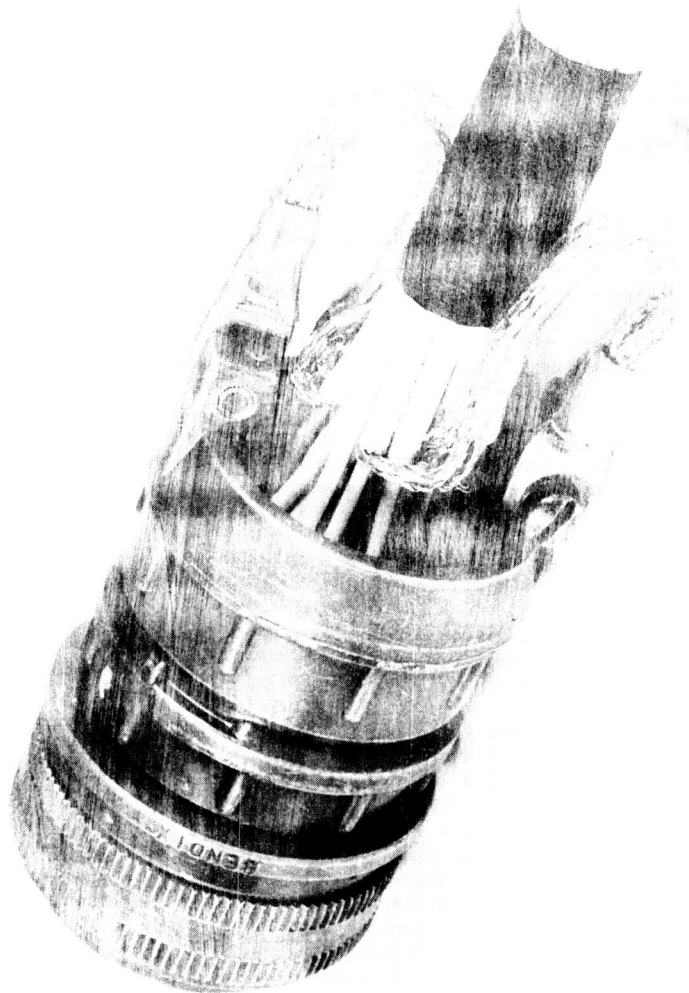


Figure 26



MS CONNECTOR WITH A FEW SHIELDS GROUNDED ON EACH SIDE  
OF THE CONNECTOR.

Figure 27

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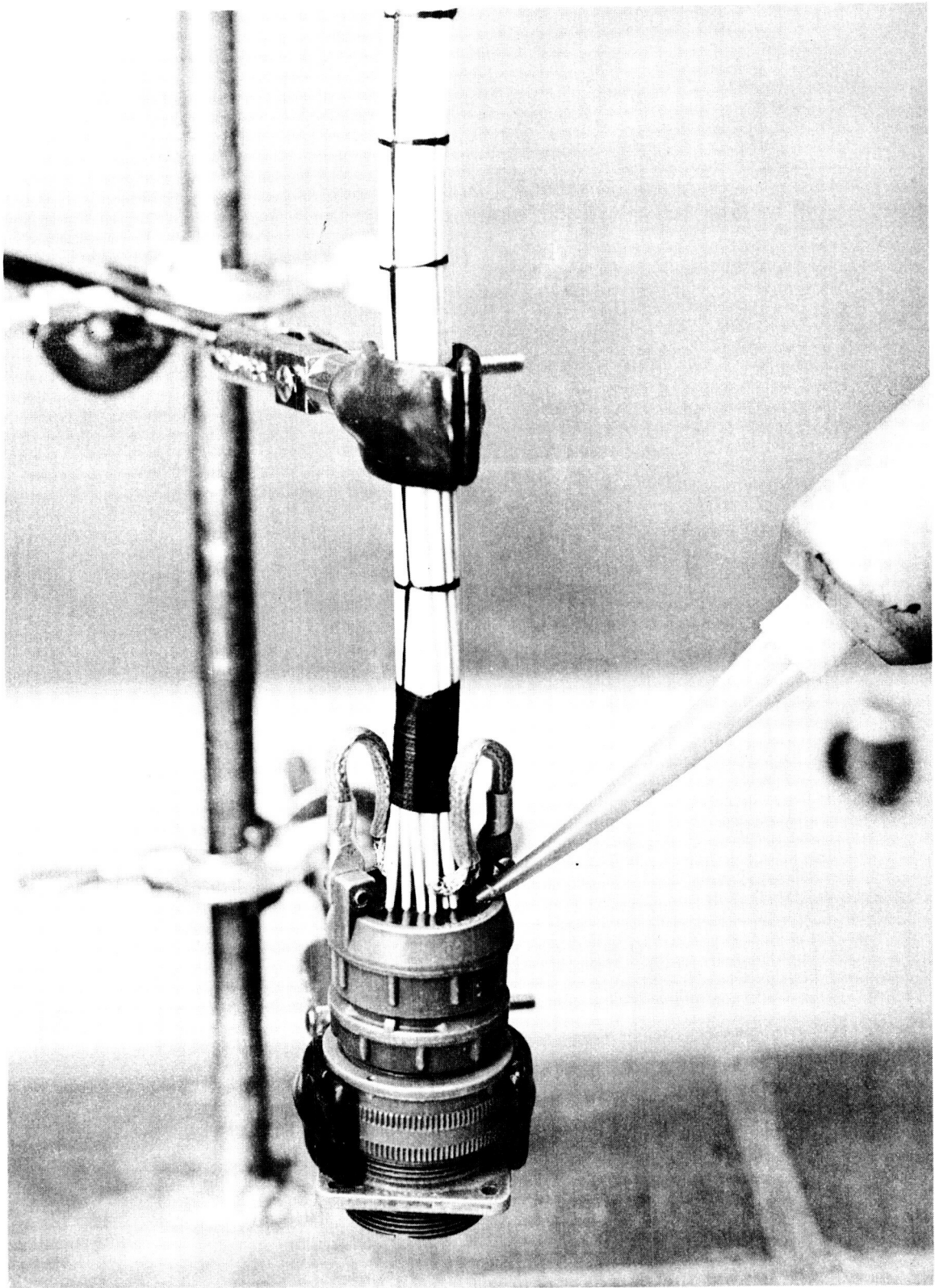
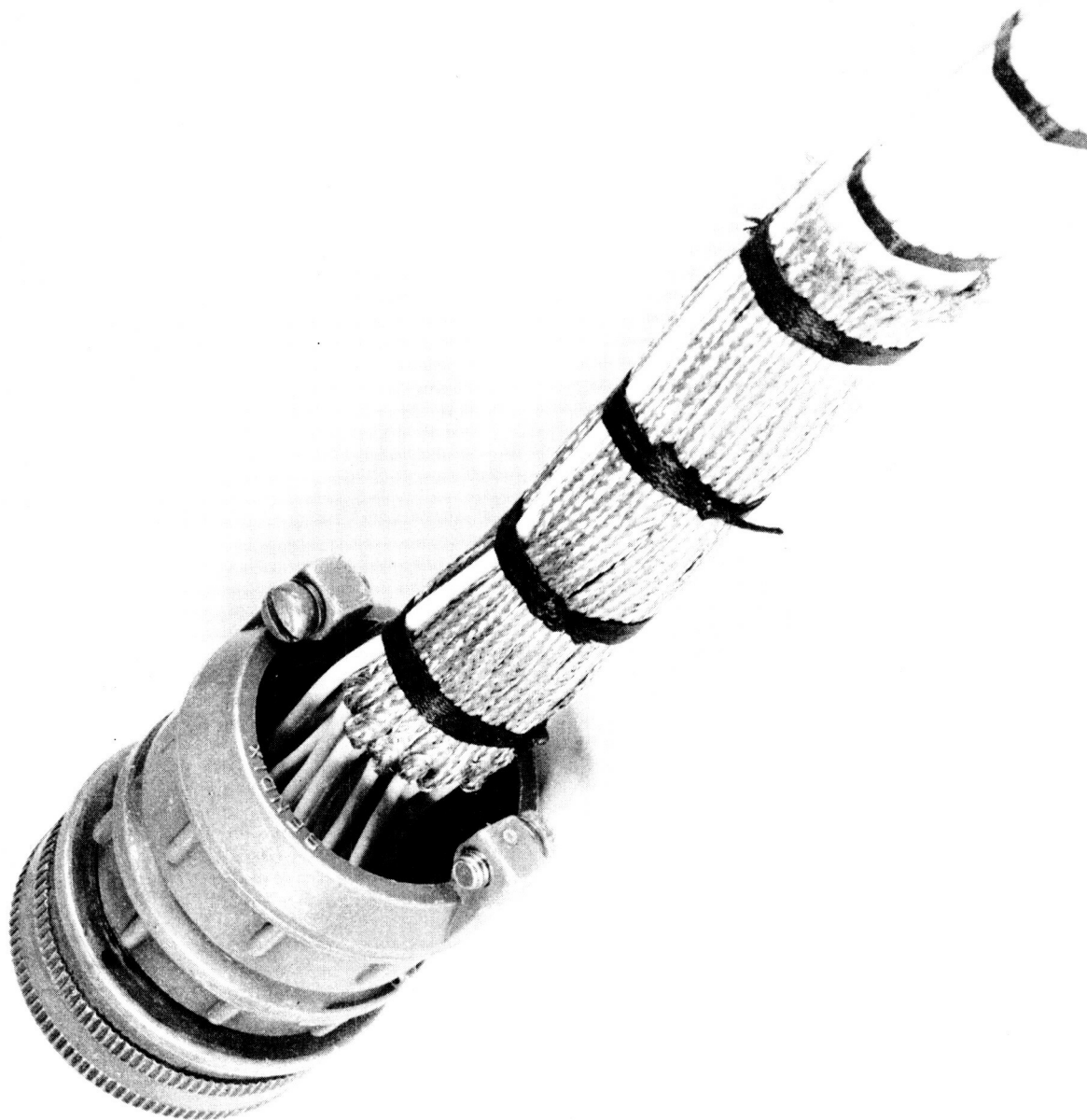


Figure 28





Figure 29



**M S CONNECTOR WITH SHIELDS TERMINATING IN A HYRING .  
THE SHIELDS ARE GROUNDED THROUGH A PIN .**

Figure 30



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April 1961

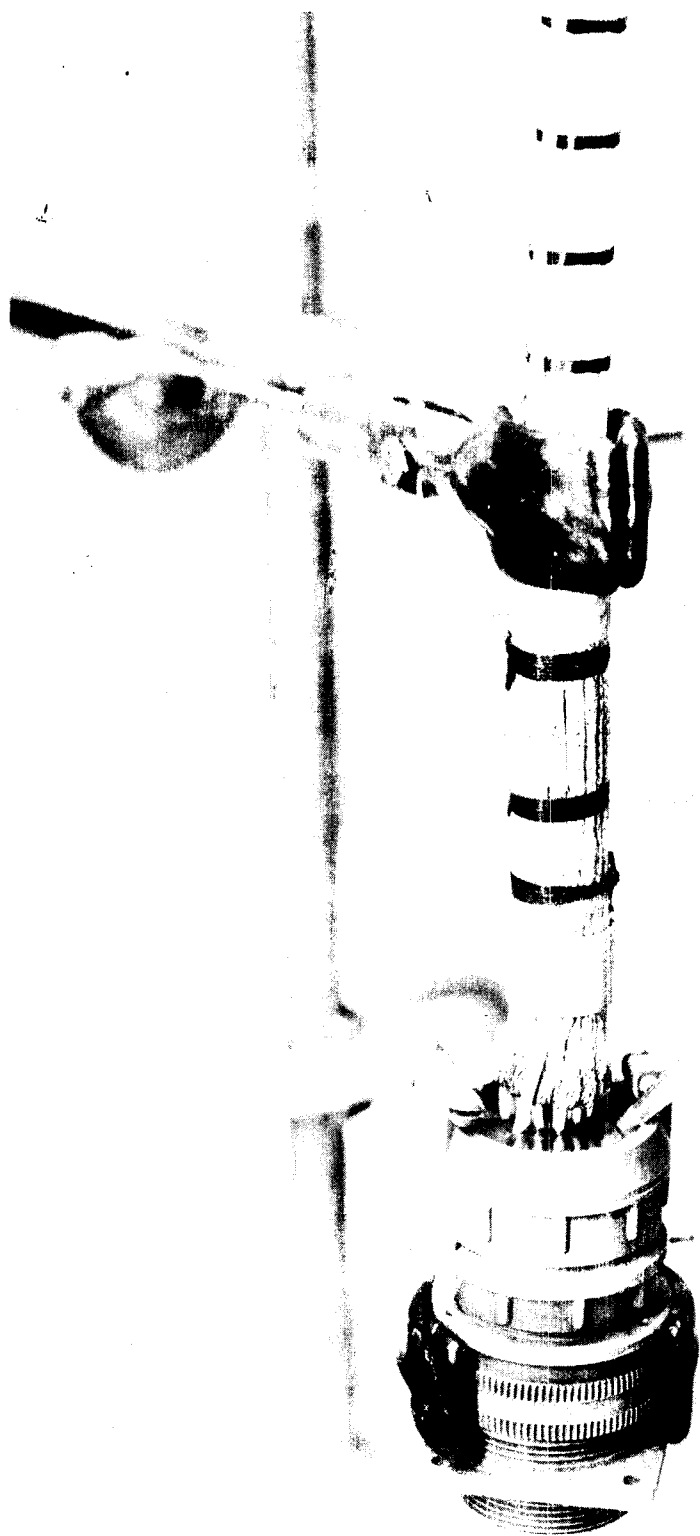


Figure 31

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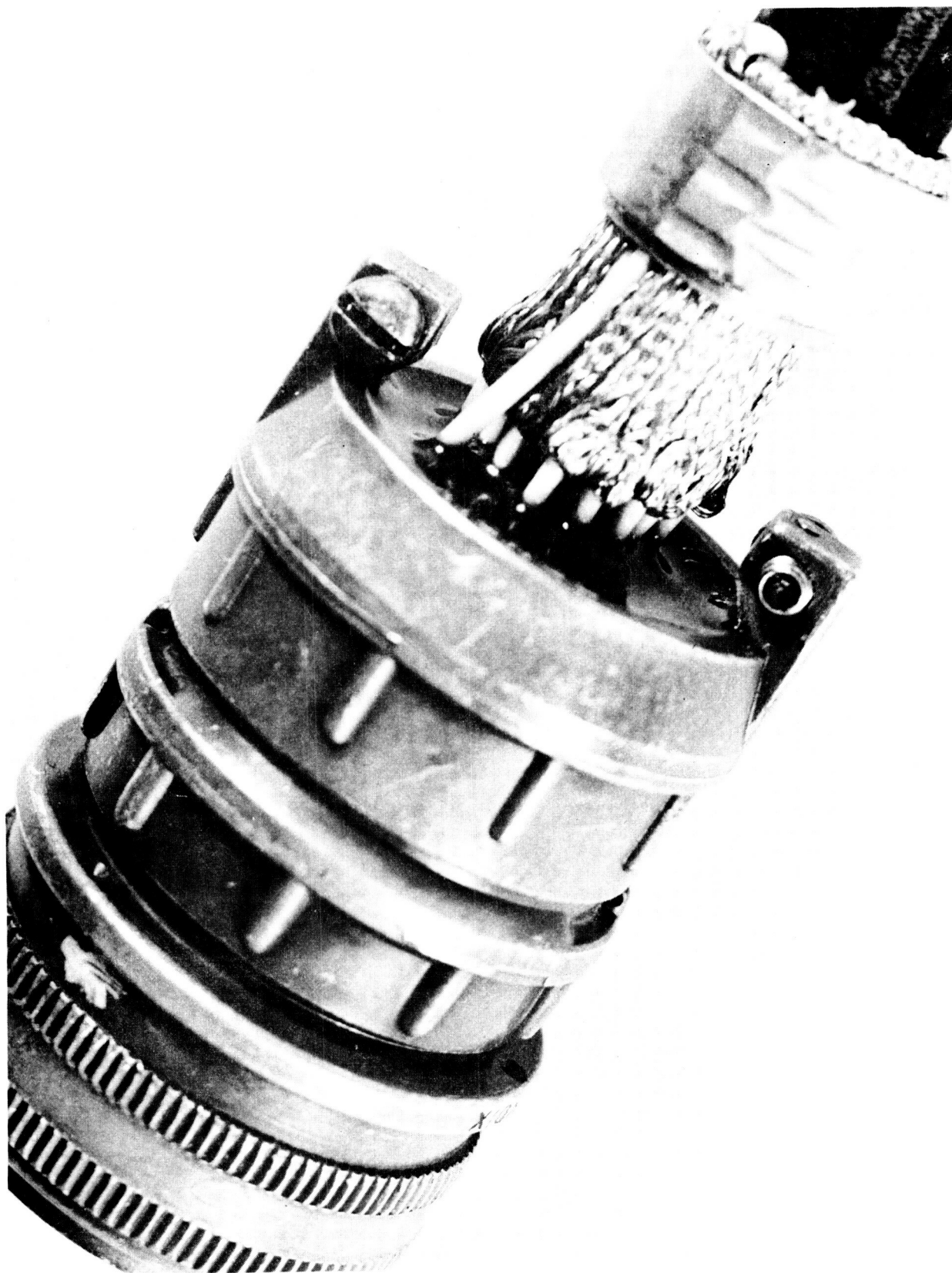


Figure 32



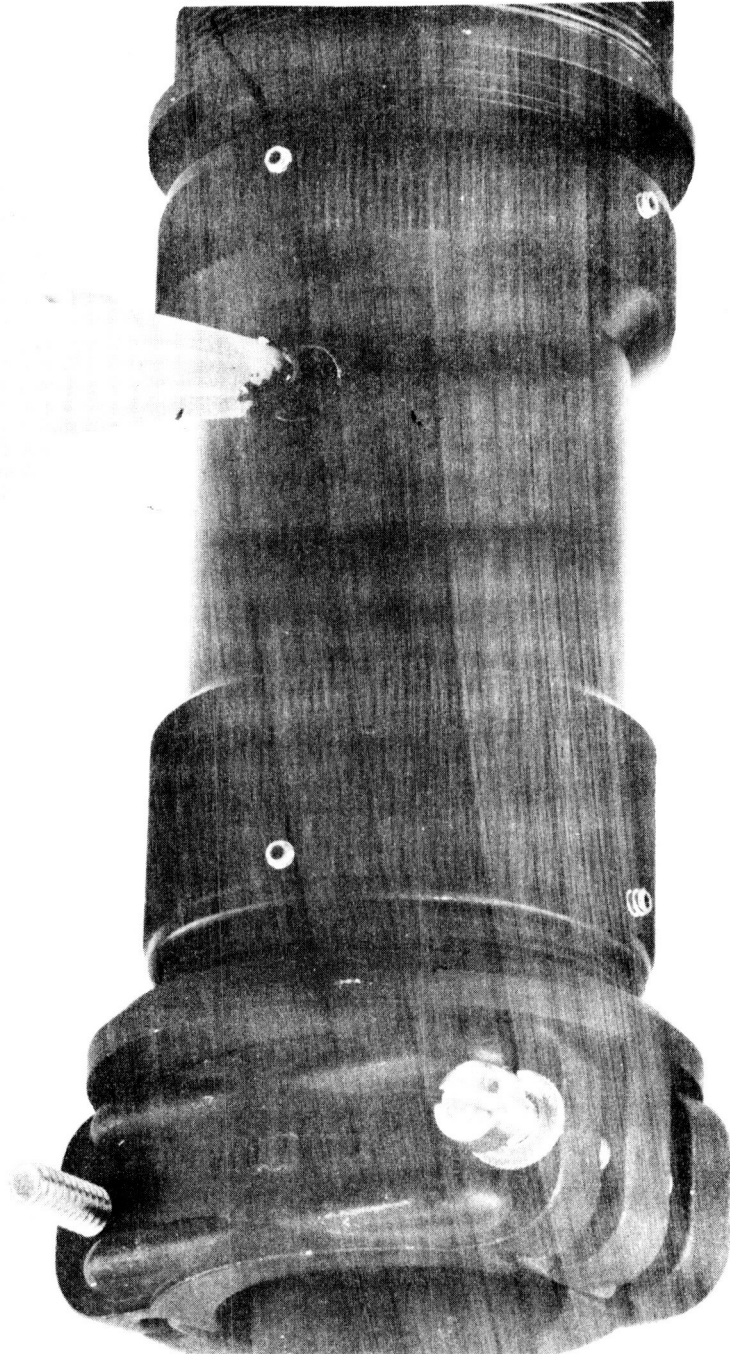
SHIELDING INSULATED BY SLEEVE.

Figure 33

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POTTING GUN



MATING  
CONNECTOR  
NOT SHOWN

HEAVY DUTY POWER CONNECTOR

Figure 34

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